Code 923 Contributions to the NPOESS Preparatory Project

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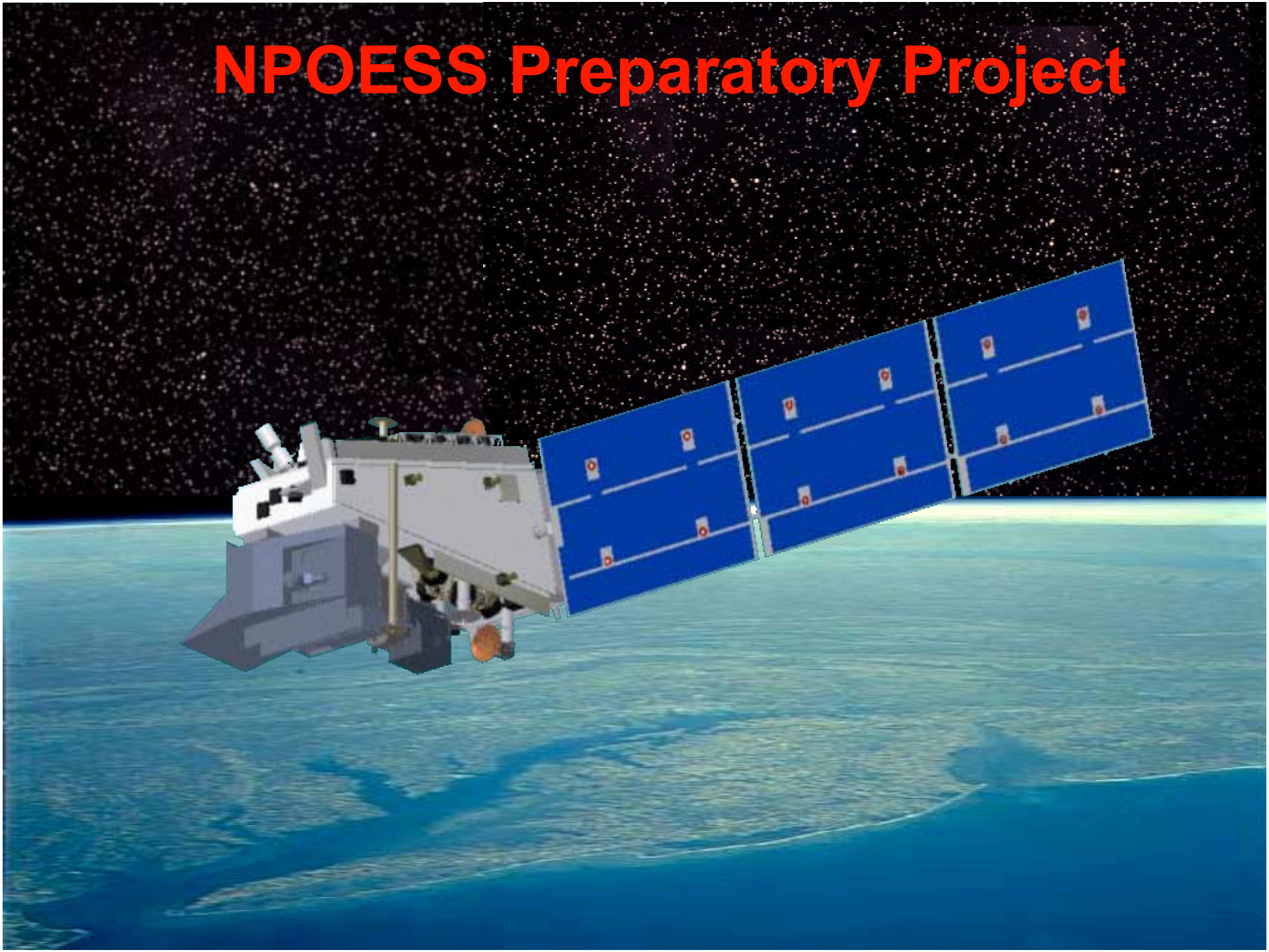
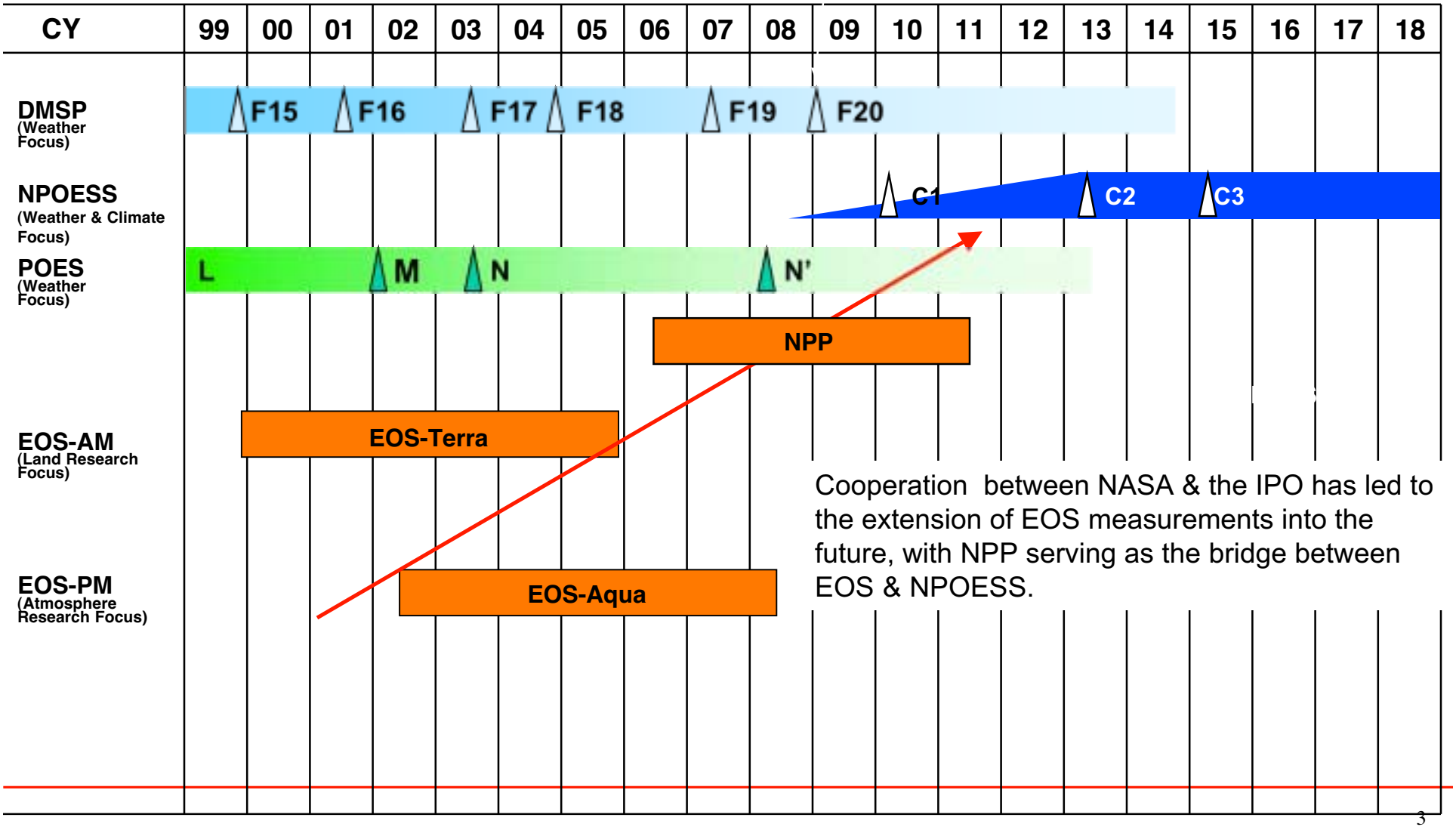
NPOESS Preparatory Project

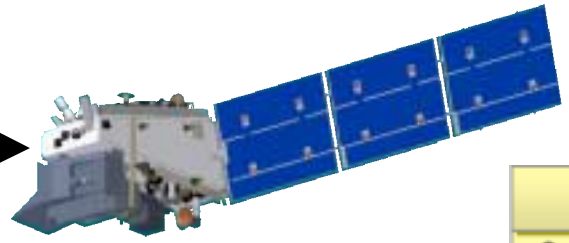


NPP Fosters Transition from Research to Operational



NPP Mission Segments

-NASA
-IPO
-NOAA



Space Segment

Launch Support Segment (LSS)
- Launch vehicle
- Launch Support
- Payload Processing support

Space Segment
- Spacecraft
- ATMS

- VIIRS
- CrIS
- OMPS

Command, Control & Communication Segment (C3S)
- Manage Mission
- Manage Satellite Operations
- Space/Ground Communication
- Data Routing & Retrieval

Interface Data Processing Segment (IDPS)
- Ingest and validate raw SMD
- Process RDRs, SDRs, EDRs
- Perform operations cal proc
- Distribute data records

Archive & Distribution Segment (ADS)
- Ingest & validate data records
- Manage archive
- Interface with users

Science Data Segment (SDS)
- Ingest and validate RDRs
- Support Climate Research

NPP Sensors Cover NASA,s ESE Needs

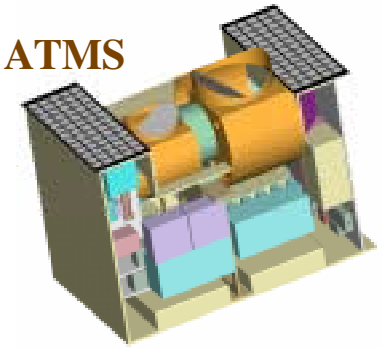
VIIRS

- Purpose: Global observations of land, ocean, & atmosphere parameters at high temporal resolution (~ daily)
- Predecessor Instruments: AVHRR, OLS, MODIS, SeaWiFS
- Management: IPO
- Status: Phase C/D (Raytheon)
- Approach: Multi-spectral scanning radiometer (22 bands between 0.4 μm and 12 μm) 12-bit quantization
- Swath width: 3000 km

CrIS

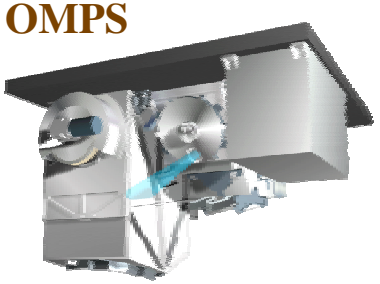
- Purpose: In conjunction with ATMS, global observations of temperature and moisture profiles at high temporal resolution (~ daily).
- Predecessor Instruments: HIRS, AIRS, IASI
- Management: IPO
- Status: Phase C/D (ITT)
- Approach: Michelson interferometer (1142 channels in 3 bands (3.5 mm >> 16 mm)
- Swath width: 2300 km
- Co-registration: with ATMS

ATMS



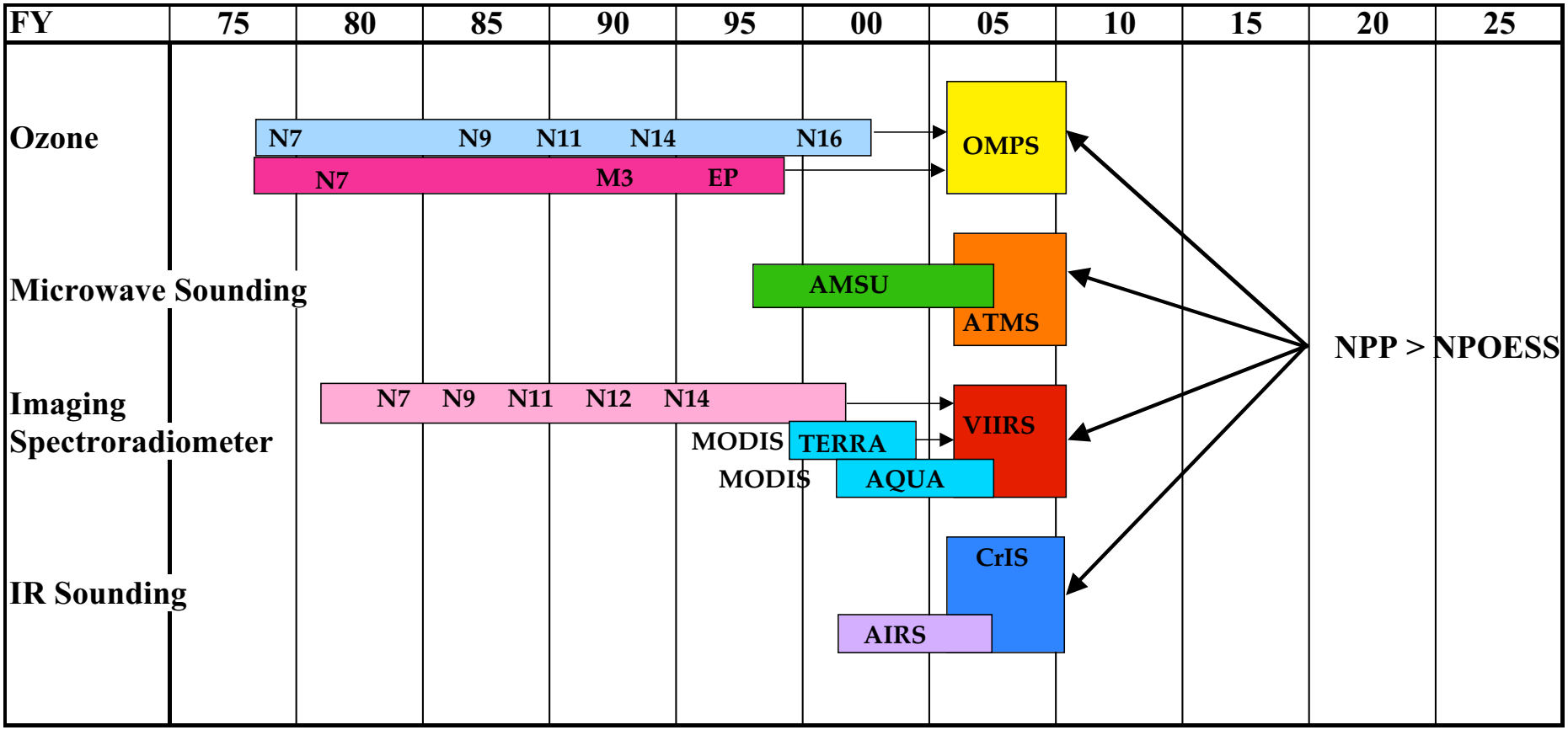
- Purpose: In conjunction with CrIS, global observations of temperature and moisture profiles at high temporal resolution (~ daily).
- Predecessor Instruments: AMSU A1 / A2, MHS
- Management: NASA
- Status: Phase C/D (Northrop Grumman)
- Approach: Scanning passive microwave radiometer (22 channels, 23 GHz >> 183 GHz)
- Swath width: 2300 km
- Co-registration: with CrIS

OMPS

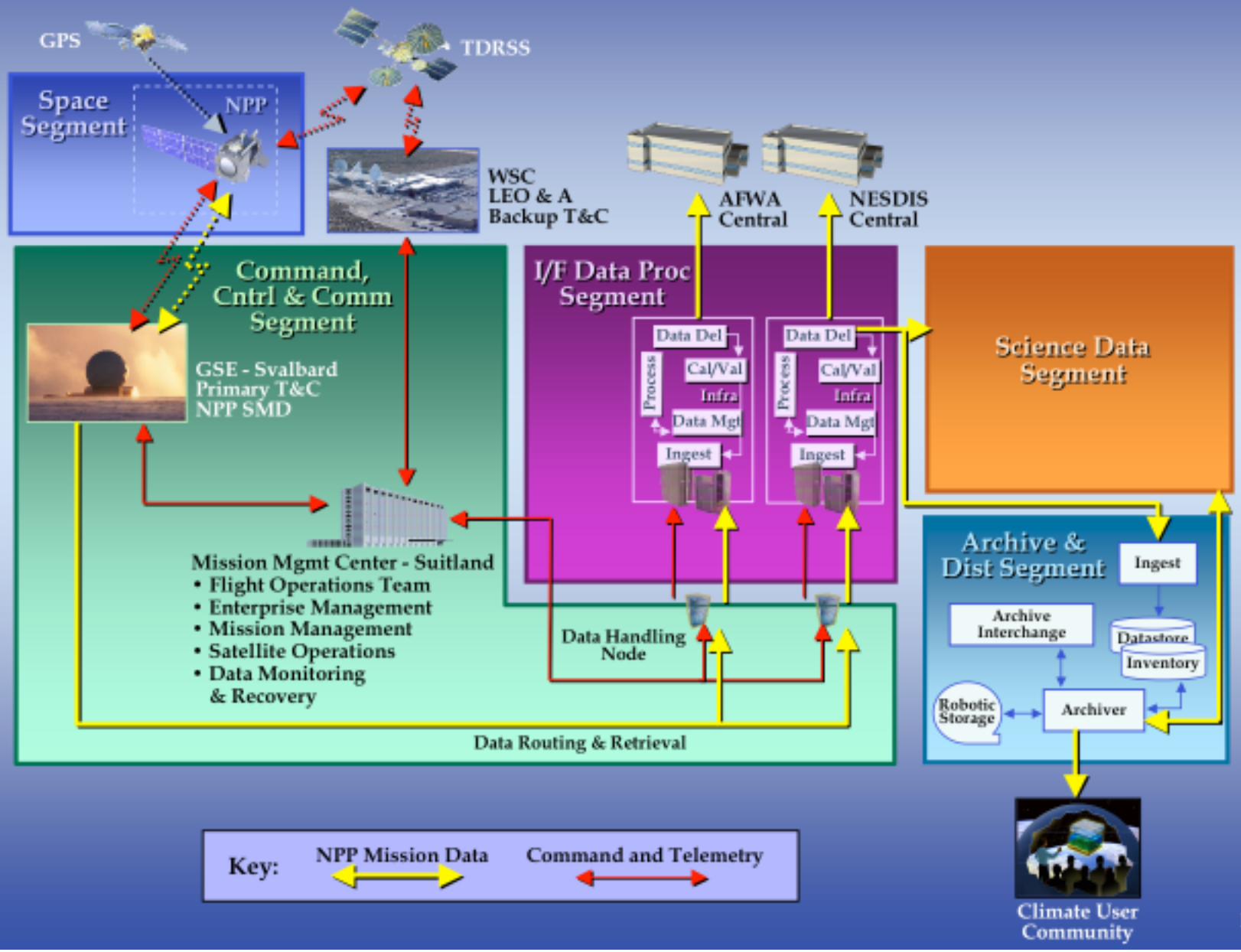


- Purpose: Provide total Ozone and Ozone profiles
- Predecessor Instruments: TOMS, SBUV/2, SOLSE
- Management: IPO
- Status: Phase C/D (Ball)
- Approach: Nadir and Limb Profiler channels
- Swath width: Nadir total column:3000 km,nadir profiler: 250x250 km, Limb Profiler 250x130 km.

NPP Continues an Observation Heritage ("that only NASA has")



NPP System Architecture



NPP Supports 24 of ESE,s Measurement Needs

Science Themes	Question	Science Requirement	Measurement Requirements	VIIRS	CrIS	ATMS	OMPS
Atmos Chemistry	Forcing 1	Volcanic gas & ash emissions	Characterize tropospheric constituents, column ozone, column SO2, ash, dust,				
Atmos Chemistry	Forcing 1	Total aerosol amount	Total aerosol optical depth				
Atmos Chemistry	Forcing 1	Stratospheric aerosol distribution	Stratospheric aersol loading/extinction, profile and particle size				
Atmos Chemistry	Forcing 1	Aerosol properties	Total aerosol optical depth				
Atmos Chemistry	Forcing 1	Volcanic gas & ash emissions	Characterize tropospheric constituents, column ozone, column SO2, ash, dust,				
Atmos Chemistry	Forcing 1	Total aerosol amount	Total aerosol optical depth				
Atmos Chemistry	Forcing 1	Stratospheric aerosol distribution	Stratospheric aersol loading/extinction, profile and optical parameter chemical				
Atmos Chemistry	Forcing 1	Aerosol properties	Total aerosol optical depth				
Atmos Chemistry	Forcing 1	Surface trace gas concentration	Determine concentrations of long-lived surface trace gas as noted via in-situ				
Atmos Chemistry	Variability 4 Prediction 4	Total column ozone	Measure stratospheric ozone cloumn over long-term for trend studies				
Atmos Chemistry	Response 1	Earth radiation budget	Measure broadband radiation; need to resolve diurnal cycle over a period of 2				
Atmos Chemistry	Forcing 2	Trace gas sources	Total column CO2 including tropospheric CO2				
Water and Energy Cycle	Variability 1	Atmospheric temperature	Measure atmospheric temperature under all weather conditions & presence of clouds				
Water and Energy Cycle	Variability 1	Atmospheric water vapor	Measure atmospheric water vapor				
Water and Energy Cycle	Variabilty1 Conseq 1	Global precipitation	Monitor rain fall				
Ecosystems	Variabilty1 Conseq 1	Land cover and land use	Coarse resolution land cover types, land cover change				
Ecosystems	Response 2	Marine productivity in coastal regions	Primary productivity, biomass, chlorophyll, absorbance of chromophoric dissolved				
Ecosystems	Variability 3	Marine primary productivity	Primary productivity, biomass, chlorophyll, absorbance of chromophoric dissolved				
Ecosystems	Forcing 2	Fire occurances and extent	Fire intensity, extent, and location; Smoke column quantity and quality				
Ecosystems	Response 2 Prediction 5	C02 and methane	Total column CO2 including tropospheric CO2				
Ecosystems	Conseq 3	Coastal region properties and	Primary productivity, chlorophyll, absorbance of chromophoric dissolved				
Oceans and Ice	Variability 2	Sea ice extent	Extent, concentration, &-albedo				
Oceans & Ice, Weather	Variability 2 Prediction 2	Sea surface temperature	Measure sea surface temperature				
Water and Energy Cycle	Response 1	Snow cover and accumulation	Measure snow extent				

NPP is a Primary Source of Data for Meeting this Requirement
NPP Contributes to Meeting this Measurement Requirement

Are the Operational EDRs Suitable for NASA,s Global Change Research?

Are the Operational EDRs Suitable for NASA,s Global Change Research?

NASA's NPP Science Team

- 24 Teams Selected in September 2003
- Kickoff Meeting in December 2003
- IFM Funding Arrived in March 2004

NASA Science Team Covers Most EDRs

Name of Product	Group	PI
Imagery *	Imagery	
Atmospheric Vertical Moisture Profile *	Atm. Sounding	Fishbein (JPL)
Atmospheric Vertical Temperature Profile *	Atm. Sounding	Fishbein (JPL)
Pressure Vertical Profile	Atm. Sounding	Fishbein (JPL)
Clear Column Radiances	Atm. Sounding	
Ozone Total Column/Profile	Atm. Sounding	McPeters (GSFC)
Precipitable Water	Atmosphere	
Suspended Matter	Atmosphere	Lyapustin (UMBC)
Aerosol Optical Thickness	Aerosol	Torres (UMBC), Lyapustin (UMBC), Schaaf (BU)
Aerosol Particle Size	Aerosol	Lyapustin (UMBC), Torres (UMBC)
Cloud Base Height	Cloud	Baum (LaRC)
Cloud Cover/Layers	Cloud	Baum (LaRC), Han (U ALA)
Cloud Effective Particle Size	Cloud	Baum (LaRC)
Cloud Optical Thickness/Transmittance	Cloud	Baum (LaRC)
Cloud Top Height	Cloud	Baum (LaRC), Han (U ALA)
Cloud Top Pressure	Cloud	Baum (LaRC), Han (U ALA)
Cloud Top Temperature	Cloud	Baum (LaRC), Han (U ALA)
Active Fires	Land	Justice (UMCP)
Albedo (Surface)	Land	Schaaf (BU)
Land Surface Temperature	Land	
Soil Moisture	Land	
Surface Type	Land	Loveland (USGS) or Ranson (GSFC)
Vegetation Index	Land	Privette (GSFC)
Sea Surface Temperature *	Ocean	Minnett (U Miami)
Ocean Color and Chlorophyll	Ocean	McClain (GSFC), Stamnes (Stevens) or Wang (UMBC)
Net Heat Flux	Ocean	
Sea Ice Characterization	Snow and Ice	Maslanik (CU)
Ice Surface Temperature	Snow and Ice	Maslanik (CU)
Snow Cover and Depth	Snow and Ice	Stamnes (Stevens)

VIIRS L1B	SDR	Menzel, Pagano, Vermote, Wolfe
CrIS L1B	SDR	Pagano, Revercomb, Strow,
ATMS L1B	SDR	Lambrigtsen, Staelin

***: items are key EDRs**

Assessing the VIIRS Surface Type EDR Using Global MODIS Data

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2 Dept. of Geography, Univ. of Maryland
3 Science Systems and Applications, Inc.

Land Cover Matters

- Land Cover is a principal factor controlling the exchange of energy, water, gases, and nutrients within the Earth system.
- Global change modeling:
  - ➢ Boundary conditions for General Circulation Models (GCM).
  - ➢ Global biogeochemical and hydrological models.
- Land cover/use *change* impacts carbon, water and energy cycles at all spatial scales…
- Ancillary data for remote sensing missions (MODIS, NPP, NPOESS)
- But also biodiversity, resource management, fire/disaster monitoring...

Table 1. SRD Requirements for the Surface Type EDR

Parameter No.	Parameter Name	Thresholds	Objectives	Specification
	a) Horizontal Cell Size			
V40.6.4-1	1) Moderate, worst case	20 km	1 km	1 km (global map)
V40.6.4-2	2) Fine, at nadir	1 km	0.25 km	1 km (global map)
V40.6.4-3	b) Horizontal Reporting Interval	(TBD)	(TBD)	1 km (global map)
V40.6.4-13	c) Horizontal Coverage	Land	Land	Land
	d) Measurement Range			
V40.6.4-6	1) Surface Type	17 IGBP classes	17 IGBP classes	17 IGBP classes
V40.6.4-7	2) Vegetation Cover	N/A	0 - 100%	0-100%
V40.6.4-8	e) Measurement Accuracy (veg. cover)	N/A	2%	20%
V40.6.4-9	f) Measurement Precision (veg. cover)	N/A	0.1%	10%
	g) Correct Typing Probability (surface type)			
V40.6.4-14	1) Moderate, worst case	70 % at (TBS) % confidence level	(TBD) at (TBS) % confidence level	88%
V40.6.4-15	2) Fine, at nadir	70 %	(TBD)	88%
V40.6.4-12	k) Minimum Swath Width (All other EDR thresholds met)	3000 km (TBR)	(TBR)	3000 km

Sensor Requirements Document, Section 3.2.1.1.1.16
(TBD: To Be Determined, TBR: To Be Reviewed, IGBP: International Geosphere-Biosphere Programme)

Surface Type

VIIRS Surface Type EDR

- Used as ancillary data for cloud mask, Land Surface Temperature, Surface reflectance, albedo, snow cover, VI
- Algorithm developed in 1999.
- Operational EDR uses high quality quarterly global land cover product updated with Fires, Snow. Produces current “green” cover fraction.
- Global product is based on AVHRR heritage:
  - Supervised approach.
  - Decision tree classifier (C5.0).
  - Yearly metrics for spectral bands, thermal, VI.
- Continuous fields products address objective requirements.

EDR/CDR Evaluation

- **We will focus on evaluating the VIIRS Surface Type EDR and in particular:**
  - **Quarterly Surface Type IP which is 'equivalent, to MODIS/AVHRR global land cover products.**
  - **EDRs/IPs that are used by Quarterly Surface Type IP:**
    - Vegetation Index EDR/IP
    - Monthly Surface Reflectance IP
    - Monthly Brightness Temperature IP
    - Snow, Fire EDRs??
  - **Quarterly Continuous Fields IP (Objective requirement).**
    - Improved MODIS algorithm will require new VIIRS approach.

Objectives

1) Evaluate performance of the current classifier OC1 with exact data/methods used to produce algorithm spec. in ATBD.

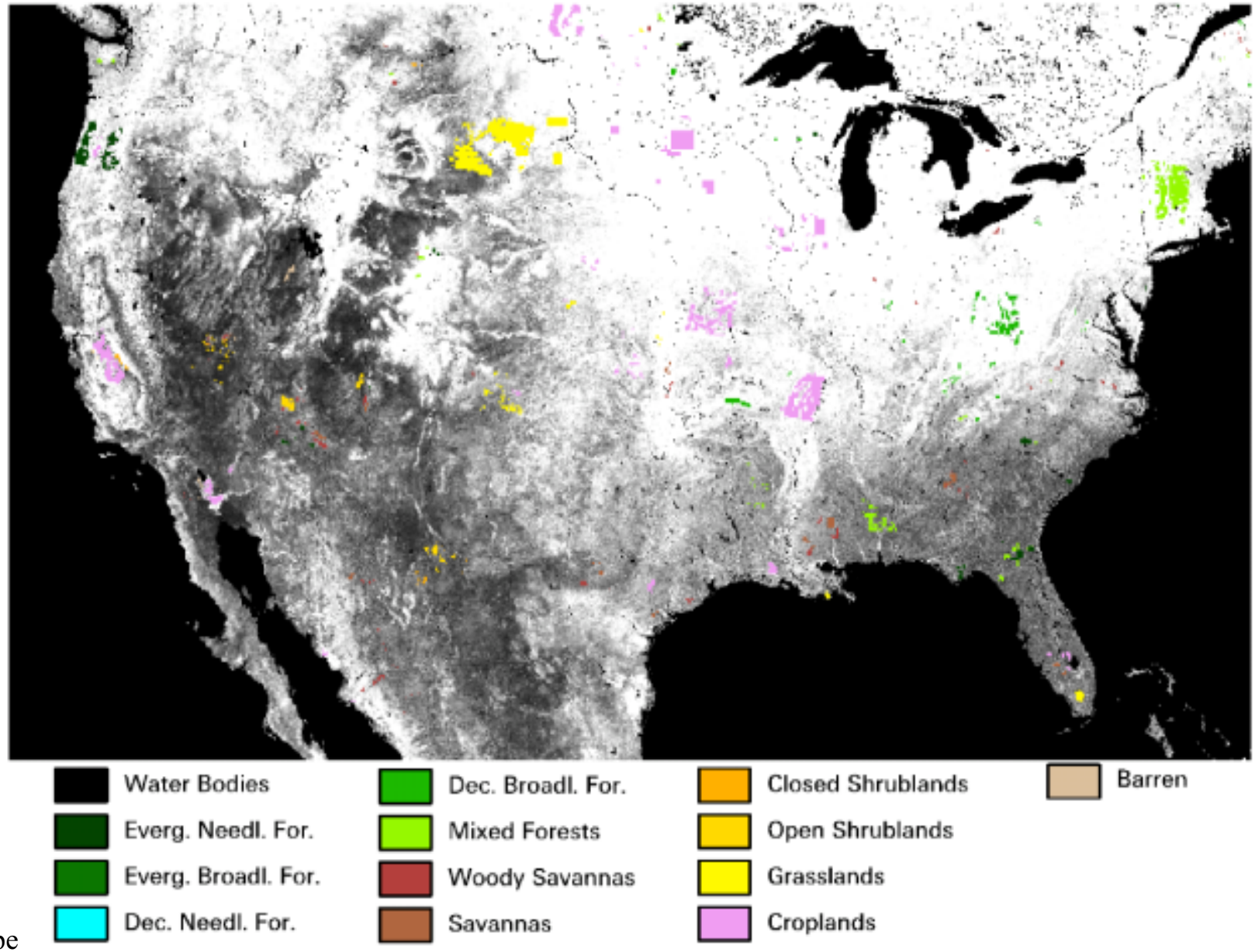
2) Evaluate OC1 and C5.0 using global, yearly temporal metrics derived from monthly MODIS data.

3) Validate performance of the classifiers against high spatial resolution data and/or field-based data.

4) Produce at-launch global surface type product (1km resolution) for NPP mission.

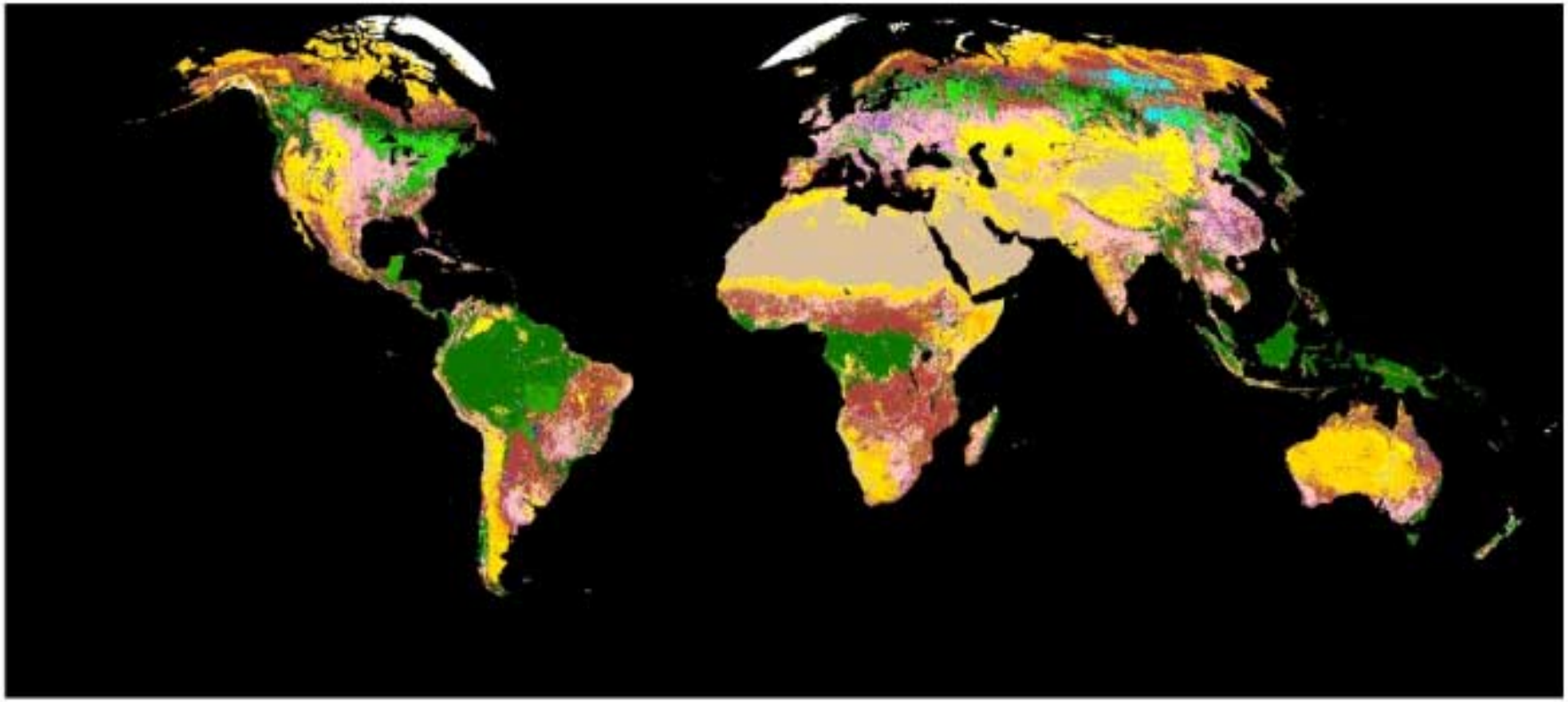
5) Recommend algorithm improvements, if any.

Example Training data derived from Landsat Data



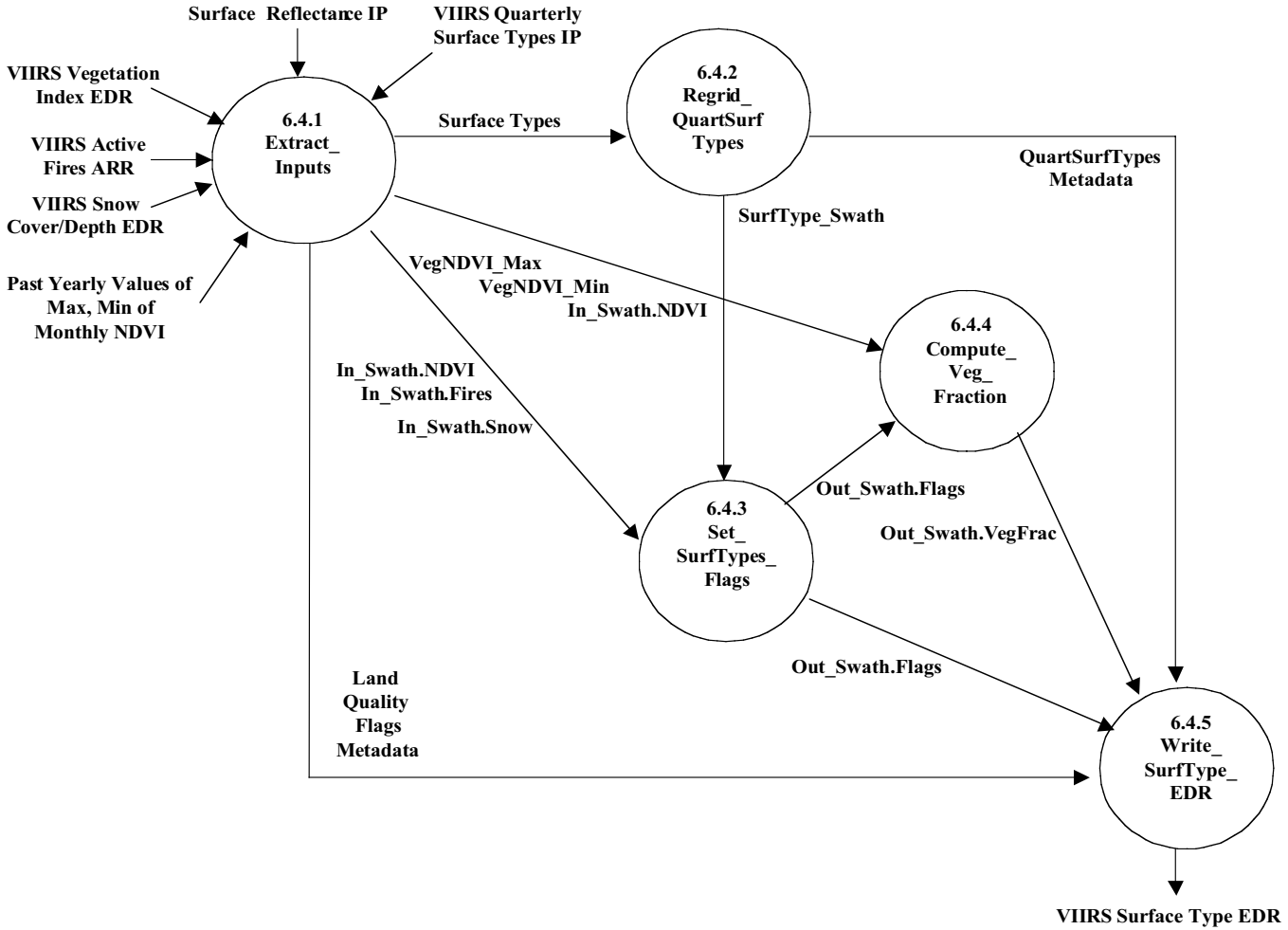
Surface Type

Prototype VIIRS 1km Classification

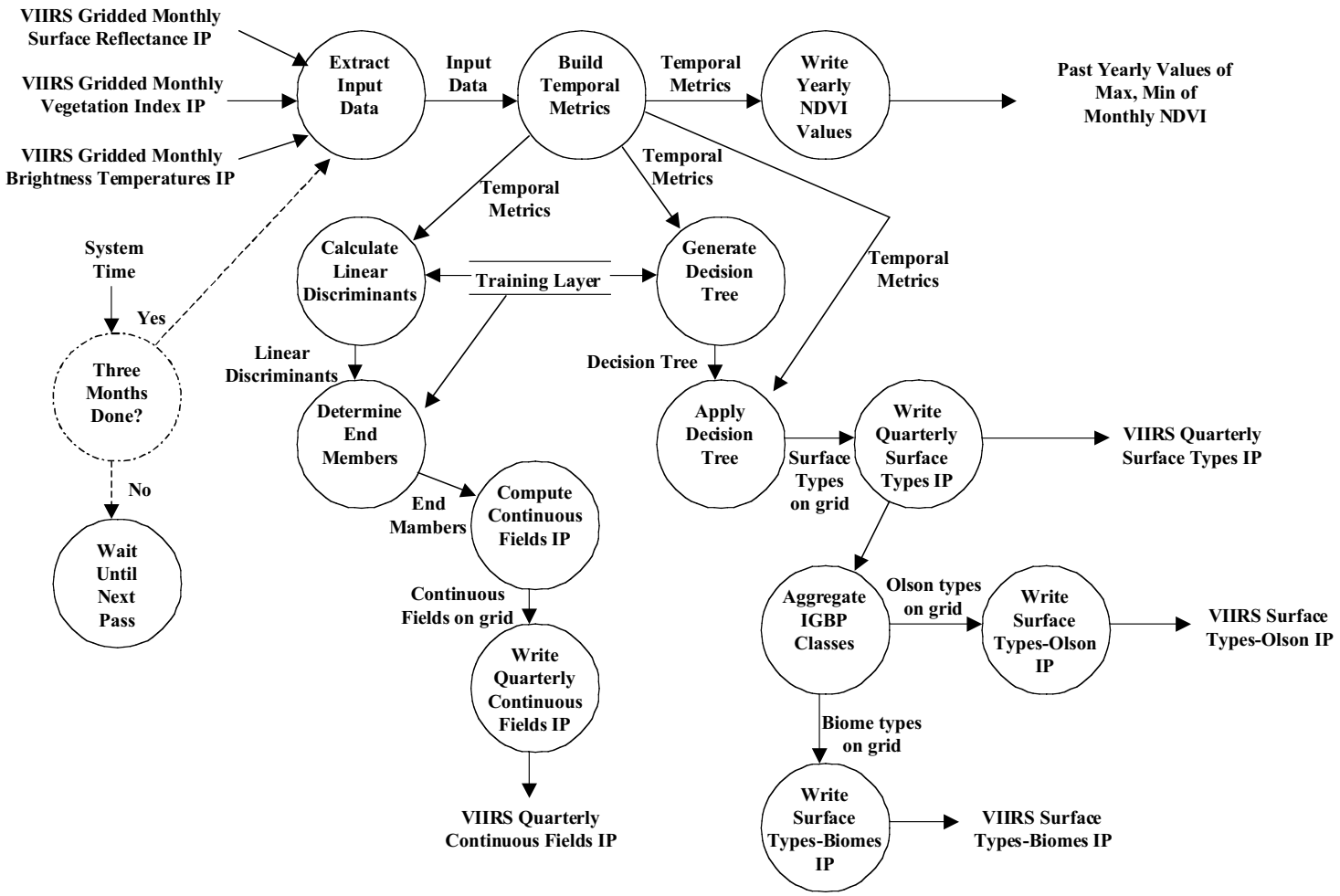


Surface Type

Operational EDR



Quarterly Intermediate Products



Vegetation Indices
Albedo
Land Surface Temperature

Team Members and Roles

- **Boston University**
  - Ranga B. Myneni, Co-I and Boston Lead
  - Yuri Knyazikhin, Co-I
- **University of Arizona**
  - Alfredo R. Huete, Co-I and Arizona Lead
- **NASA,S Goddard Space Flight Center**
  - Jeffrey L. Privette, PI and NASA Lead

Primary EDR Interests

- **Vegetation Index**
  - **Observed Top-of-Atmosphere NDVI**
  - **Observed Top-of-Canopy EVI**
- **Surface Albedo**
  - **Daily**
  - **Instantaneous “Blue Sky”**
  - **Two algorithms (multi-regression, BRDF magnitude inversion)**
- **Land Surface Temperature**
  - **Dual Split Window**

Primary EDR Interests

- **Vegetation Index**
  - **Observed Top-of-Atmosphere NDVI**
    MODIS Nadir-Normalized TOC NDVI
  - **Observed Top-of-Canopy EVI**
    MODIS Normalized TOC EVI
- **Surface Albedo**
  - **Daily** **MODIS 16-day**
  - **Instantaneous "Blue Sky"** **MODIS "Black" and "White Sky"**
  - **Two algorithms (multi-regression, BRDF magnitude inversion)**
    MODIS main algorithm: full BRDF inversion
- **Land Surface Temperature**
  - **Dual Split Window**
    MODIS 'Day/Night, and Single Split Window